THE MEDUSAE FOSSAE FORMATION, AMAZONIS PLANITIA, MARS: EVALUATION OF PROPOSED HYPOTHESES OF ORIGIN.

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Thick (up to 3 km) and areally extensive (over 2 million square km) deposits in the Amazonis Planitia region of Mars (12S to 18N, 125 to 220W) cover both the heavily cratered highland terrain south of the equator and moderate- to lightly-cratered plains north of the highlands. These enigmatic materials have been mapped as the Medusae Fossae Formation (MFF). We have begun a reexamination of the MFF deposits in an attempt to establish constraints that may help to discriminate between the various working hypotheses of origin. Excellent Survey mission Viking images show a wealth of morphologic detail exposed within the MFF deposits. Through a combination of geologic mapping, remote sensing data analysis, and consideration of likely terrestrial analogs, a list of the most viable hypotheses may be produced and certain key future observations identified to refine the proposed hypotheses.

General Description

The MFF materials have flat to gently undulating surfaces that lack obvious lava flow morphologies, display one or more prominent joint trends at various locations, have very few superposed impact craters (implying a young surface age, provided that craters have not been obliterated), and are very thick (approaching a depth of 3 km in some locations). Locally, the deposits have been subdivided into 3-7 units [1, 2]. When imaged at high resolution, there is considerable evidence of erosion, including some of the most extensive yardang fields on the planet, with the associated implication that the materials themselves are very friable.

Proposed Modes of Origin

Several hypotheses have been proposed to explain the formation of the MFF deposits. Here we discuss several of the major hypotheses. Similarities between terrestrial ignimbrites and the MFF deposits (*e.g.*, joint sets, possible welded zones) have been noted by several researchers [1-4]. Possible layering within some MFF deposits was interpreted by others to be massive accumulations of variably indurated aeolian material [1,5-9]. The MFF materials, along with other units distributed about Mars, were proposed to be paleopolar layered materials deposited when Mars' rotation axis was at a different position [10]. The Gordii Dorsum escarpment that cuts through the MFF materials was proposed to be an exhumed transcurrent fault, implying an old age for the materials that were subjected to extensive chemical alteration at depth [11]. Recently the possibility of a large northern ocean late in the history of Mars led to the proposal that the MFF materials are an ancient carbonate platform [12], or pumice layers that accumulated along the shore of this ocean [13]. Some additional working hypotheses for MFF include widespread outflows of very porous lava or palagonite-rich mudflows from eruptions that tapped subsurface ice [7].

Current Studies

Images obtained late in the Survey mission of Viking Orbiter 1 (orbits 1462 to 1473, with 30-33 m/pixel resolution), cover a significant portion of the MFF materials. Digital processing and mosaicing of selected images and geologic mapping of surfaces exposed between 2.5 and 7.5 N, 140 and 145 W, permits distinction of three units within what had been mapped as the middle member of the MFF [1]. Photoclinometry of exhumed impact craters and erosional escarpments indicates a minimum thickness of 200-300 m for each of these three units. Mapping also reveals abundant evidence of intense erosion [9], interpreted here to be predominantly aeolian in origin. Some surfaces exhumed from beneath the friable deposits show impact craters and apparent lava flow fronts [9,14]. We believe that the complex erosional and exhumational story preserved within the MFF deposits is the key to unraveling the origin of these materials. Our initial efforts have focused on developing specific criteria for evaluating the erosional history of MFF and the consequent implications for each of the proposed hypotheses of origin.

Aeolian erosional features are common throughout the MFF deposits and include pedestal craters, windstreaks, fluted escarpments with marginal mesas and plateaus, and irregular hollows. Some apparently related aeolian dunes also occur. In addition, extensive yardangs formed in the three units comprising the middle MFF possess differing orientations and are suggestive of changeable prevailing winds over time. Based on estimates of yardang relief in the region (7), erosion locally accounts for removal of ~200 m of the deposits. Greater erosion likely characterizes locations where wholesale removal of some units occurred. Collectively, the observed suite of erosional features in the MFF appear consistent with those associated with terrestrial pyroclastic and aeolian deposits among others.

As the details of the erosional history are unraveled, we will proceed to an examination of remote sensing and field data for the Los Frailes ignimbrite in Bolivia as a specific test of the ignimbrite hypothesis for MFF. The Los Frailes ignimbrite covers 8500 square kilometers of the high plains in central Bolivia [15], where limited rainfall and intense aeolian activity make this location a good potential analog for volcanic deposits under Martian conditions. Landsat TM data of the Los Frailes materials are comparable in spatial resolution to the best Viking images of MFF, and the spectral characteristics of the relatively unvegetated ignimbrite [16] should result in useful constraints for understanding the remote sensing properties of the MFF materials on Mars.

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